.MMOND PROJECT, NEW MEXICO

COLORADO RIVER STORAGE PROJECT

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A Report of reappraisal of direct agricultural bene-fits and project impacts

U. S. DEPARTMENT OF AGRICULTURE
Salt Lake City, Utah

OUR SOIL ★ OUR STRENGTH

USDA-SCS-PORTLAND, OREG.-1957 M-1740

UNITED STATES DEPARTMENT OF AGRICULTURE

REPORT OF

REAPPRAISAL OF DIRECT AGRICULTURAL BENEFITS

AND PROJECT IMPACTS

HAMMOND PROJECT

NEW MEXICO

COLORADO RIVER STORAGE PROJECT

COOPERATING AGENCIES

Soil Conservation Service
Agricultural Research Service
Forest Service
Farmers Home Administration
Agricultural Stabilization & Conservation Committees
New Mexico Agricultural Experiment Station
New Mexico Cooperative Extension Service
State Engineer of New Mexico

In Coordination With
Bureau of Reclamation
United States Department of the Interior

Report Prepared By

USDA Field Advisory Committee & USDA Field Party

Salt Lake City, Utah - November 1957

CONTENTS

CONTENTS

REPORT ON REAPPRAISAL OF DIRECT AGRICULTURAL BENEFITS & PROJECT IMPACTS

HAMMOND PROJECT - NEW MEXICO

SUMMARY

Authority and Scope

This report on the Hammond project, Colorado River Storage Project, has been prepared by the U. S. Department of Agriculture in response to the President's letters of March 19, 1954, to the Secretary of Agriculture and the Secretary of the Interior. In his letters, the President requested that a reappraisal of the direct agricultural benefits anticipated from the participating projects of the Colorado River Storage Project be made by the Department of Agriculture in cooperation with the Department of the Interior. Following the authorization of the Colorado River Storage Project by Congress, an understanding was reached in July 1956 between the Secretary of Agriculture and Secretary of the Interior regarding conduct of a survey to reappraise direct agricultural benefits and to appraise project impacts. The Department of Agriculture survey was made under the authority of Section 6, Public Law 566, 83d Congress, as amended, which authorizes the Department to cooperate with other federal, state, and local agencies in surveys and investigations of watersheds. The New Mexico College of Agriculture and Mechanic Arts cooperated in the survey.

In addition to the agricultural phases, this report deals with the impacts of the project on the national forests and the relationship of watershed conditions to the project.

This report is also intended to aid the Bureau of Reclamation in developing a sound project plan and to provide information bearing on regular programs of this Department.

General Description

The Hammond project is located on the south side of the San Juan River in northeastern San Juan County, New Mexico. Average elevation of project lands is 5,400 feet; the climate is arid with an average annual precipitation of approximately 9 inches and a frost-free period of 155 days. Irrigation is necessary for successful crop production. Under irrigation, most field crops can be grown, and the climate is favorable for the raising of fruit, especially apples.

Proposed Project Development

The project will provide water for irrigating 3,900 acres of land. Adequate water will be supplied by the authorized Navajo Reservoir, a large storage project on the San Juan River. Water will be diverted from the river and conveyed to the project through a main canal, which will include several tunnels and large siphons.

Evaluation of Expected Direct Agricultural Benefits

Procedures and Sources of Information

This report is based on available field data, published reports, and the combined judgment of agricultural technicians familiar with the project area and its agricultural problems and conditions. The Bureau of Reclamation has furnished the USDA Field Party with preliminary reports, land classification maps and field sheets, farm worksheets, and information regarding the acreage and location of lands to be included in the project. This information is used to augment soil surveys, field investigations, engineering surveys, crop yield determinations, and irrigation water investigations made by members of the USDA Field Party, Soil Conservation Service, Forest Service, Agricultural Research Service, and Bureau of Indian Affairs. In addition, assistance from representatives of the New Mexico College of Agriculture and Mechanic Arts, New Mexico Cooperative Extension Service, New Mexico Agricultural Experiment Station, Farmers Home Administration, Bureau of Land Management, State and County Agricultural Stabilization and Conservation Committees, and others was valuable in preparing the report.

Evaluation Areas

For analytical purposes, project lands are grouped into three evaluation areas. Lands within each evaluation area are sufficiently similar in soils, climate, and water supply to reflect similar crop adaptations, productivity, land and irrigation development, production costs, and other factors associated with economic returns. Evaluation areas A and C include only new land while evaluation area B includes land presently irrigated and new land. Evaluation area A comprises 1,516 acres; evaluation area B, 1,959 acres; and evaluation area C, 425 acres.

Presently irrigated lands were placed in cultivation only recently and are in the initial stage of development. Problems connected with delivery of water to these lands were costly, and the history is inadequate as a basis for projecting costs and returns without the project. For this reason, the analysis treats the presently irrigated lands the same as new lands.

Soils

A complete coverage of a soil-type survey made by the Soil Conservation Service in 1940 (converted to the conservation survey symbols) served as the basis for soil inventory information. Bureau of Reclamation field sheets and soil profile information were valuable in making the conversion. Soil problems of major importance are susceptibility to erosion, undulating slopes, poor physical condition of soil due to alkali, low organic matter and fertility, and a tendency toward soil compaction.

Based on the survey, it is concluded that the 3,900 acres in land capability classes I, II, and III are approximately the same as the 3,900 acres of irrigable land for which the Bureau of Reclamation plans to supply irrigation

water and which are considered suitable for long-continued cultivation under irrigation. This acreage is divided into the three evaluation areas mentioned above, and analytical data in the report is presented on this basis.

Irrigation Supplies and Requirements

Several comprehensive studies were made of irrigation requirements in the immediate vicinity of the Hammond project. These data, with information supplied by personnel familiar with the area, are the basis for determining irrigation water requirements.

Based on a weighted average net seasonal consumptive use requirement of 21.3 inches per acre and an estimated on-farm irrigation efficiency of 55 percent, the estimated net farm irrigation delivery requirement per irrigable acre is 36.0 inches of water. Proposed project facilities will deliver 36.2 inches of irrigation water at the farm headgate. This will assure that the irrigation water requirements for the 3,900 acres of irrigable land in the project will be fully met by the proposed project facilities.

Land and Irrigation Development

Development requirements for project lands are estimated by evaluation areas on the basis of the average level of management expected on the project and are consistent with anticipated irrigation efficiencies and expected crop yields. Costs include land clearing, land leveling, and development of the on-farm irrigation system. Weighted average net development costs per acre of irrigable land for evaluation area A are $67.15; evaluation area B, $117.91; and evaluation area C, $94.63.

Projected Agricultural Economy

Five general farm types are projected with development of the project.

Fruit - Thirty to 40 acres in size and comprising 11 percent of the irrigable project acreage.

Grade-A Dairy - Eighty to 95 acres in size and comprising 31 percent of the irrigable project acreage.

Cash Crop - One hundred and twenty to 140 acres in size and comprising 28 percent of the irrigable project acreage.

Breeding Beef Cattle - One hundred and twenty to 140 acres in size and comprising 20 percent of the irrigable project acreage.

Farm Flock of Sheep - One hundred and twenty to 140 acres in size and comprising 10 percent of the irrigable project acreage.

Farm budgets are used in determining the probable net incomes of farmers from operations of the five general types of farms. Projected prices, costs, yields, and management practices are used in making the farm budget analysis.

This analysis shows, with the project, a weighted average of about $5,800 net income per farm. This amount is available for family and operator labor and management, investment in land and irrigation water, and annual payment of related water costs.

The residual approach is used to determine the direct agricultural benefits. For analytical purposes, livestock and associated incomes are omitted from farm budgets. This approach eliminates an income and benefit problem related to processing feed through livestock enterprises and allocating returns to the appropriate resources. On this basis, direct agricultural benefits amount to $14.73 per acre for evaluation area A, $7.31 per acre for evaluation area B, and $64.53 per acre for evaluation area C. Weighted average direct benefits for the 3,900 irrigable acres in the Hammond project amount to $16.43 per acre, or a total of about $64,000 annually. A 100-year evaluation period is applied in the benefit analysis. The use of a 50-year period would decrease the direct agricultural benefits by $0.77 per acre, or a total of about $3,000 annually.

Impact of the Hammond Project on National Forest Lands

The Hammond project will have no foreseeable impact upon national forest lands.

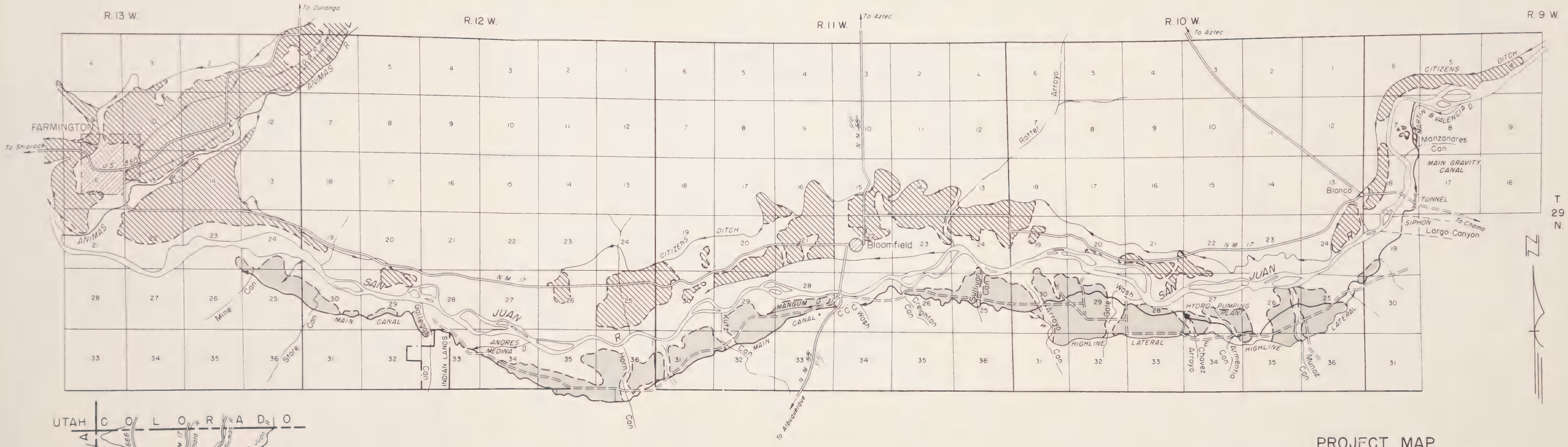
Relationship of Watershed Conditions to the Hammond Project

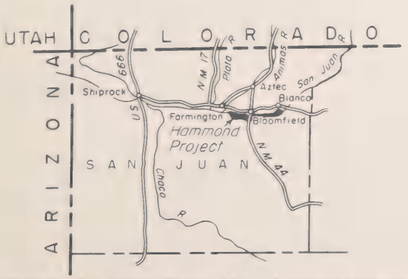
Watershed conditions covered in this report should not materially affect feasibility of the project; however, improvement in the condition of watershed lands will reduce operating difficulties and maintenance expenses. Watershed lands that affect the Hammond project include those tributaries to the San Juan River which drain into the river between the authorized Navajo Dam and Hammond project diversion, plus those drainages that cross project lands. Navajo Dam will serve as a control point, and watershed areas draining into the San Juan River above that point are not described in this report.

Watershed lands generally have only fair to poor vegetative cover and contribute large amounts of sediment. They are used chiefly for grazing by livestock and big game animals. Land ownership is 83 percent federal and 17 percent private.

Plans developed by the Bureau of Reclamation provide structural measures and channelization of major drainages through project lands. Installation of land treatment measures in critical areas will do much to improve the condition of watershed lands.

Conservation programs are presently being installed on most of the lands in the watershed. These programs include such measures as adjustment of grazing numbers, livestock water development, fencing, reseeding, brush eradication, and installation of erosion control structures. These programs should be accelerated by land-administering agencies and private range operators so that watershed conditions can be improved, thus lessening the hazard of flood and sediment damages to the project.





LEGEND

- Presently Irrigated Lands (non-project)
- Hammond Project Lands

PROJECT MAP
HAMMOND PROJECT
SAN JUAN COUNTY, NEW MEXICO

SEPTEMBER 1957

0 1 2 3

SCALE IN MILES

U.S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE USDA-SCS-PORTLAND, OREG. 1957 M-1737-2

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CHAPTER I

GENERAL INFORMATION

Organization

Pursuant to the U. S. Department of Agriculture Memorandum of Understanding between the Soil Conservation Service, Forest Service, and Agricultural Research Service dated February 2, 1956, a USDA Field Advisory Committee, Colorado River Storage Project, was established. The committee is composed of a representative from each of the above-mentioned agencies and a member representing the concerned state agricultural colleges. Principal duties of the committee are to maintain appropriate liaison and facilitate coordination of activities by the respective services and the state agricultural colleges in the survey. Field relationships with the Bureau of Reclamation and other interested state and federal agencies are also a responsibility of the committee.

A USDA Field Party, working under direction of the USDA Field Advisory Committee and operating within a plan of work dated August 22, 1956, is headquartered at Salt Lake City, Utah. The party is responsible for the collection and analysis of data and the preparation of this report.

Description of the Area

Location and Physical Features

The Hammond project is located on the south side of the San Juan River in northeastern San Juan County, New Mexico. Project lands lie in a narrow strip (about 20 miles long with a maximum width of 1.5 miles) paralleling the river. They begin approximately 1 mile below Blanco, New Mexico and extend to approximately 3 miles above the town of Farmington, New Mexico. Project lands are located in the river valley and range from about 5,300 to 5,600 feet in elevation. The project is in the San Juan Basin which is part of the Inter-Montane Plateaus Division of the Colorado Plateaus Physiographic Province.

The San Juan River rises in the San Juan Mountains of southwestern Colorado, crosses the Colorado-New Mexico state line in a southwesterly direction, flows westward near the corner common to Colorado, New Mexico, Arizona, and Utah, and joins the Colorado River in southern Utah. Some of its most important tributaries above the project are the Navajo, Piedra, and Los Pinos Rivers. Below the project the most important tributaries are the Animas, La Plata, and Chaco Rivers.

Several arroyos cross project lands from the south and discharge into the San Juan River. These drainages include Canon Largo, Armenta Canyon, Munoz Arroyo, Chavez Arroyo, Kutz Canyon, and Gallegos Canyon.

Project lands are within the boundary of the San Juan Soil Conservation District organized October 24, 1941. Ownership of project lands is 90 percent private (47 owners), 8 percent federal, and 2 percent state.

Climate

Weather Bureau stations are maintained at Aztec, Bloomfield, and Farmington, New Mexico. The station near Bloomfield, at an elevation of 5,794 feet, has been operated since 1891 and is probably most representative of the climate of the project lands. Precipitation averages approximately 9 inches annually, of which an estimated one-half falls during the growing season, and varied from a low of 3.05 inches in 1950 to a high of 20.68 inches in 1941. Maximum and minimum temperatures recorded near Bloomfield are 106° F. and -35° F., respectively. The mean annual temperature is 51.1° F., and relative humidity is usually low.

The project area has a temperate arid climate satisfactory for diversified irrigation farming as practiced along the San Juan River. Dryland farming is impractical. The frost-free period averages 155 days; the last killing frost occurs around May 8, and the first killing frost comes around October 9. Average annual evaporation at Farmington is 53.71 inches.

Present Agriculture

History of Development

Settlement of the San Juan Valley was started soon after 1870. Attempts to irrigate some lands in the vicinity of the Hammond project began about this time. The original Hammond Canal was built in the early 1880's and, at one time, irrigated as much as 2,000 to 2,500 acres of land. The project was gradually abandoned between 1912 and 1916 because of the difficulty of maintaining the canal crossing at Canon Largo and the Recurring need for maintenance and repair of other flood-damaged structures. Since that time, other attempts were made to irrigate portions of these lands. Several irrigation ditches now furnish a partial water supply to certain irrigated land within the project area.

Agricultural Development

Until recently the San Juan Basin was predominantly an agricultural area. The recent discovery of oil and gas fields and the expansion of this industry have changed the major economic activity of the basin from agriculture to industry. However, agriculture is still a principal source of income with livestock production, irrigation farming, and the processing of farm products providing considerable employment.

Irrigation farming is concentrated in the irrigated valleys of the San Juan, Animas, and La Plata Rivers. The towns of Farmington, Bloomfield, and Aztec are trading and shipping centers. Present agricultural patterns on farms near Bloomfield, across the river from project lands, are beef, sheep, dairy, fruit, and general field crops.

The growing season permits the raising of most field crops and is favorable for fruit, especially apples. Alfalfa, apples, corn, beans, barley, and pasture will be the principal crops.

Economic Conditions

General economic conditions in the region and in the communities near the project area have been highly favorable for the past several years. Population of San Juan County increased from 14,701 in 1930 to 18,113 in 1950 and was estimated to be 45,000 in 1956. The 1950 population for towns near the project was 3,672 in Farmington and 896 in Aztec. Population estimates for these towns in 1956 were Farmington, 15,000, and Aztec, 5,300. Industrial expansion due primarily to the development of large producing gas and oil fields and the nearby discovery of uranium has been tremendous. Several pipelines transport gas to markets throughout the west. Small industries located in or near the trading centers also help to support this local economy. Because of the boom in the general economy of the San Juan area, there is a definite need for additional agricultural products.

General

The project area has good transportation facilities. A narrow-gauge branch line of the Denver & Rio Grande Western Railroad Co. connects Durango, Colorado with Aztec and Farmington. U. S. Highway 550 and State Highways 17 and 44 serve this part of the San Juan Basin. Highway distance from Bloomfield to Albuquerque is 179 miles.

Telephone and electric facilities are available at Bloomfield. Communities adjacent to the project area are well established, and public grade and high schools are available. Churches of various denominations are established in these communities.

Proposed Development

The Hammond project would divert water from the San Juan River to irrigate 3,900 acres of land. This water will be supplied from the authorized Navajo Reservoir, a large storage project on the San Juan River. Project works would consist of the Hammond project diversion on the San Juan River, a main gravity canal, a hydraulic turbine-driven pump to serve a highline canal, and distribution and drainage systems. The main canal will include several tunnels and syphons across and through escarpments and drainageways which bisect project lands.

CHAPTER II

EVALUATION OF DIRECT AGRICULTURAL BENEFITS TO BE EXPECTED FROM THE HAMMOND PROJECT

In evaluating the direct agricultural benefits to be expected from the project, the following steps were taken:

1. Project soils and their suitability for irrigation were inventoried.
2. Irrigation water supplies and requirements were analyzed.
3. Necessary land and farm irrigation development was estimated.
4. Evaluation areas were established.
5. Size and type of farming expected with project development, together with anticipated crops and crop yields, were projected.
6. Net farm incomes expected with the proposed project were analyzed.
7. Direct agricultural benefits were estimated.

During the past few years some lands in the proposed project area were cleared and leveled in varying degrees. They are now receiving a partial water supply from several gravity and pump diversions. These lands have only recently been producing crops and are in the initial stage of development. Most of these lands receive water from the Kutz Canyon Irrigation Co. which pumps water from the San Juan River. Costly difficulties were encountered with the pumping of silty water, interruption of water deliveries due to pump breakdown, frequent water shortage in the San Juan River, and other problems.

In attempting to determine differences to be expected under present conditions projected into the future and future development with the project, the lack of adequate records of costs and returns for the partially developed lands became apparent. The operating history was too short and inadequate to furnish a basis on which to forecast future irrigation costs and returns.

For analytical purposes it was decided to treat these partially developed lands the same as new lands because of the relatively short experience under irrigation and uncertainty regarding some features of the present operations.

Evaluation Areas

To facilitate the presentation of basic agricultural data and to assist in the evaluation of direct agricultural benefits, project lands were grouped into evaluation areas. The lands within each evaluation area are sufficiently similar in soils, climate, and water supply to reflect similar crop adaptations, productivity, land and irrigation development, production costs, and other factors associated with economic returns.

The following evaluation areas are recognized on the Hammond project:

Evaluation Area A - This includes deep, permeable, easily managed, well drained, medium textured soils on slopes of 2 percent or less. These soils have medium water intake rates and high water-holding capacity and can be irrigated by runs which require a minimum amount of labor to attain a high degree of irrigation efficiency. Lands in this group will produce high yields of all adapted crops. Average development costs per acre are low.

Evaluation Area B - Included in this group are well drained, deep soils which, because of texture, slope, topography, or a combination of these factors, are more difficult to manage. The water intake rates and water-holding capacity of the soils in this group are not as favorable as those in evaluation area A. Efficient irrigation will involve shorter length of runs and more frequent irrigations with resulting increase in labor. Anticipated crop yields and irrigation efficiencies are lower, and cost of development is higher than for lands in evaluation area A.

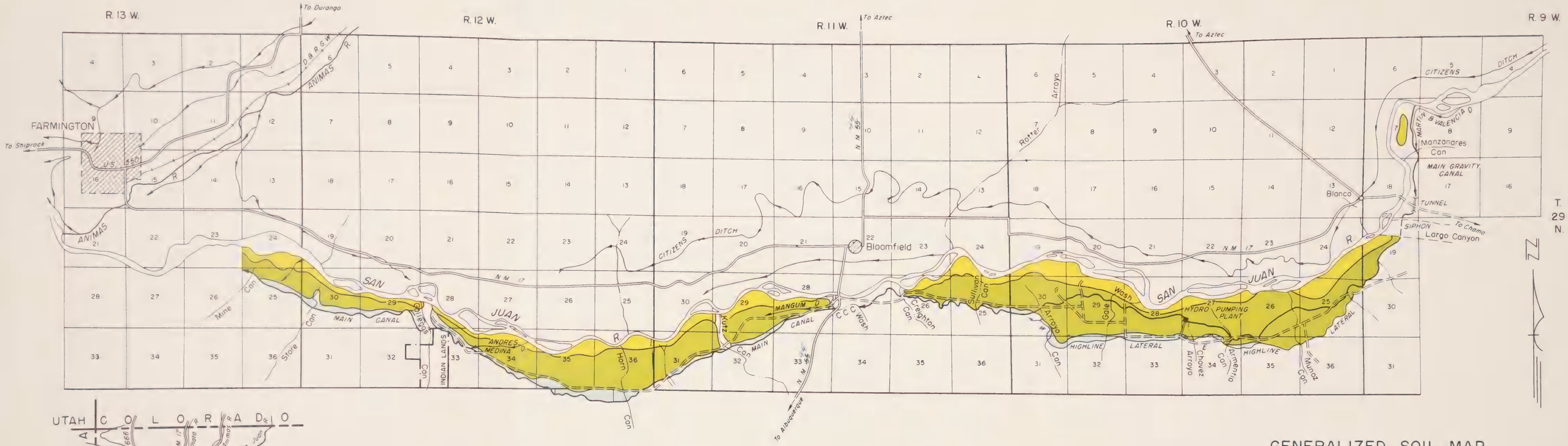
Evaluation Area C - This group includes deep, medium textured, permeable soils on slopes ranging from 4 to 6 percent. These soils have medium intake rates and medium water-holding capacity. Soils can be irrigated with long runs, provided they are bench leveled and additional labor is expended. Frequency and efficiency of irrigation under bench leveled conditions is expected to be equal to land in evaluation area A. Soils will not permanently produce high yields of all adapted crops unless additional cost of development and operations is incurred to protect them from erosion. Permanent production without these precautions would require less intensive use with a lower income. Due to the location of soils in this group with respect to air drainage, they are particularly adapted to production of fruit. This would be the favored use due to higher incomes expected. Estimated cost of development for orchard use is expected to be more than for evaluation area A and less than for evaluation area B.

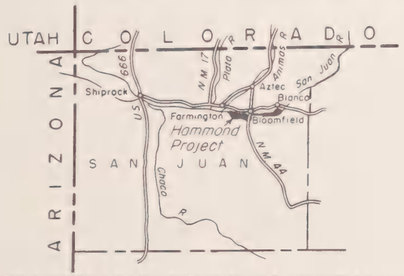
Evaluation area A comprises 1,516 acres; evaluation area B, 1,959 acres; and evaluation area C, 425 acres, totaling 3,900 acres. These evaluation areas will be recognized throughout this report, and crop production, land development costs, the economic analysis, and other aspects of the evaluation of direct agricultural benefits will be discussed in terms of these areas.

Soil Inventory

Sources of Data

Soil data were obtained from a soil-type survey of the Hammond project completed by the Soil Conservation Service in 1940. This earlier soil survey was adapted to the conservation survey symbol by local Soil Conservation Service soil scientists after field checking. Bureau of Reclamation field sheets and soil profile information were valuable in making these conversions. Information on the acreage and location of irrigable lands received from the Bureau of Reclamation serves as the basis for compiling soil survey data for this report.





LEGEND

- Recent Alluvial Soils From General Mixed Alluvium
- Recent Alluvial Soil From Local Mixed Alluvium
- Recent Alluvial Soil From Local Alluvium

GENERALIZED SOIL MAP
HAMMOND PROJECT
SAN JUAN COUNTY, NEW MEXICO

SEPTEMBER 1957

0 1 2 3
SCALE IN MILES

U.S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE USDA-SCS-PORTLAND, OREG.-1957 M-1737-1

7-E-20037-N

General Description of Soils

Slopes generally range from 1 to 12 percent from the sandstone ridge on the south side of the project toward the San Juan River on the north. Dissecting the project at frequent intervals are deep drainageways from which deep alluvium, of sandstone and shale origin, has been deposited over river material. Periodic deposition is responsible for the highly stratified soils in the project. Degree of stratification and complexity of the soil pattern become progressively greater from the south side of the project to the north.

These deep, well drained, permeable soils reflect the semidesert climate under which they have developed. With some exceptions, soils have little or no profile development, are calcareous throughout, and are low in organic matter and fertility. Generally, the soils are highly susceptible to erosion and, due to the sharp, angular, well graded sand fraction, are easily compacted when moist. Texturally, the soils feel sandy when dry, but when moistened and worked, the sand is almost masked by the clay.

Three principal soil groups, based on their position and complexity, are shown on the Generalized Soil Map and are described as follows:

1. Recent alluvial soils derived from general mixed alluvium are subject to erosion and deposition from the river. They are very productive soils but are highly susceptible to overwash and deposition of river-born material as well as waterlogging and salt accumulation. Alluvium from side drainages has influenced the soil of small areas near the confluence of the drainageways and the river. This highly complex soil pattern is further complicated by the extreme variability in sequence of different textured layers in the soil profiles. These layers may be loamy sand to clay-loam textures, and soils may be very deep to shallow over river gravel and cobbles. Slopes range from 0 to 3 percent and may be smooth but are predominantly undulating.

2. Recent alluvial soils derived from local mixed alluvium lie above the river influence. This group extends east and west in a band through the project. In area it is the largest group and, except for about one-fifth of the area being alkali-affected, it represents the best soils on the project for long-continued cropping under irrigation. The soil pattern is less complex, and soils do not exhibit extreme stratification. Occasionally there is a sizeable area of very deep, uniform, medium textured soils, but most of them are coarse textured in the substratum. Some of the soils have "B" horizons and a zone of high lime accumulation. Solonetzic "B" horizons are spotty throughout the alkali-affected soils.

3. Recent alluvial soils derived from local alluvium generally lie just below the sandstone hills on the south side of the project. They are rapidly permeable and coarse textured throughout. Slopes are generally undulating and range from 3 to 12 percent. Because the slopes are generally steeper than the other two groups, these soils have a greater erosion hazard, and use should be confined

to close growing crops or orchard with cover crop. Because of the coarser texture and steeper slopes, these soils are more difficult to manage and have a narrow range of crop adaptability.

Soil Problems

Soil problems of major importance are susceptibility to erosion, undulating slopes, poor physical condition of soil due to alkali, low organic matter and fertility, and a tendency toward soil compaction.

The erosion hazard on slopes over 1 percent is increased by the sharp, angular sand fraction in these soils and should be one of the principal considerations in planning crop rotations and the management of irrigation water. Slopes are generally undulating throughout the project area, and controlled water application can be achieved only by land leveling.

Using the Bureau of Reclamation land classification information, alkali-affected soils were separated into two groups: (1) Mapping units with more than 25 percent of the area affected by sodium, and (2) mapping units with less than 25 percent of the area affected. The percentage of the area affected with sodium is associated with the density of old, large greasewood (Sarcobatus vermiculatus) plants. Most of the sodium is in the upper 12 to 15 inches of soil. Under average management, soil so affected is difficult to reclaim. Within the project area there are some soil mapping units with less than 25 percent of the area affected which are in the process of being reclaimed. The fields are usually seeded to barley then to alfalfa with heavy applications of manure on the alkali spots. Other soil delineations with more than 25 percent of the area affected are excluded from the project by the Bureau of Reclamation.

These soils of an arid climate are inherently low in organic matter and are also low in nitrogen and phosphorus. Such deficiencies under irrigation can be overcome with good crop rotations and application of commercial fertilizer; however, if excess irrigation water were applied, plant nutrients will be leached away, and the benefits of water will be reduced.

Most of the soils above the river influence have a well graded sand fraction which increases the susceptibility to compaction and reduces infiltration. Compaction can be kept to a minimum by reducing tillage operations on these soils when they are moist and by good crop rotations to increase the organic matter.

Water loss from unlined canals and excessive irrigation in permeable, higher lying soils can result in an accumulation of sodium salts and a waterlogged condition on lower lying soils. These hazards should be reduced considerably with canal lining proposed by the Bureau of Reclamation and the higher irrigation efficiency expected with a dependable water supply.

Land Capability Classification

For classification purposes, soil mapping units are grouped into land capability units which include the class, subclass, and unit.

Land capability unit II s 2b

II - Represents the land capability class, which is one of eight broad national classes of land.

s - Represents the subclass, which is one of four broad national divisions of the land capability class.

2b - Represents the unit, which is a local division of the subclass identifying a specific land condition.

The land capability class shown by roman numeral expresses the severity of the limitation in use. As the class increases numerically, the severity of the limitations increases. (Land capability classes shown below are those recognized on the Hammond project. There is no land capability class V in the project.)

Class I - Good land suitable for cultivation with no limitations in use and suitable for all climatically adapted crops.

Class II - Moderately good land suitable for cultivation having moderate limitations in use but suitable for all climatically adapted crops.

Class III - Fair land suitable for cultivation having severe limitations in use and not suitable for all climatically adapted crops.

Class IV - Land suitable only for close growing crops or orchards with cover crops.

Class VI - Land not suitable for cultivation but good land for range or woodland use.

The subclass expresses the general reason for the limitation in use, such as e, erosion; s, soil; w, water; or c, climate. The unit reflects the specific problem(s) requiring treatment.

Below the Bureau of Reclamation proposed canal system, there are 3,983 acres in land capability classes I, II, and III and 1,762 acres in class IV totaling 5,745 acres. Included in class IV are 1,181 acres of alkali-affected soil and 581 acres of steeply sloping soil best suited to close growing crops or orchard with cover crop. Use of class IV land may be justified, if irrigation water were available, where small acreages are interspersed with better land of a farm unit.

Table 1.- General soil characteristics by land capability units, Hammond project

Land capability units	General soil characteristics						Acres
	Texture	Permeability	Depth	Percent slope	Topography	Alkali	
I	medium	moderate	deep	0 - 1	smooth	none	227
IIs2b	moderately fine	moderately slow	deep	0 - 3	smooth	none	106
IIs2b1	moderately fine	moderately slow	deep	1 - 3	undulating	none	60
IIs3a	moderately coarse	moderate	deep	0 - 1	smooth	none	88
IIs4a	moderately coarse	moderately rapid	deep	0 - 1	smooth	none	30
IIs4a1	moderately coarse	moderate and moderately rapid in the subsoil and rapid in the substratum	deep	0 - 1	undulating	none	26
IIe3a	medium	moderate	deep	1 - 3	smooth	none	1,491
IIe3a1	medium	moderate	deep	1 - 3	undulating	none	489
IIe3b	medium	moderately rapid	deep	1 - 3	smooth	none	10
IIIs4	moderately coarse	moderately rapid	deep	1 - 3	smooth	none	423
IIIs4l	moderately coarse	moderately rapid	deep	0 - 1	undulating	none	20

Table 1.- General soil characteristics by land capability units, Hammond project, cont.

Land capability units	General soil characteristics						Acres
	Texture	Permeability	Depth	Percent slope	Topography	Alkali	
IIIs42	moderately coarse	moderately rapid	deep	1 - 3	undulating	none	60
IIIe3a	moderately coarse	moderate	deep	3 - 6	smooth	none	468
IIIe3a1	moderately coarse	moderate	deep	3 - 6	undulating	none	40
IIIe4	moderately coarse and medium	moderate	deep	1 - 3	smooth	none	445
IVs2	moderately coarse	moderately rapid to rapid	moderately deep	0 - 1	smooth	none	2
IVs2b	moderately fine	moderately slow	deep	0 - 3	smooth	moderate	260
IVs2b1	moderately coarse	moderately rapid to rapid	deep	0 - 1	undulating	moderate	15
IVs3b	medium	moderate to moderately rapid	deep	0 - 3	smooth	moderate	365
IVs3b1	medium	moderate to moderately rapid	deep	1 - 3	undulating	moderate	386

Table 1.- General soil characteristics by land capability units, Hammond project, cont.

Land capability units	General soil characteristics						Acres
	Texture	Permeability	Depth	Percent slope	Topography	Alkali	
IVs3b2	medium	moderate to moderately rapid	deep	3 - 6	smooth or undulating	moderate	155
IVs4	moderately coarse	rapid	deep	1 - 3	undulating	none	105
IVe4a	medium and moderately coarse	moderate and moderately rapid	deep	6 - 12	smooth	none	380
	moderately coarse	moderately rapid	deep	3 - 6	smooth	none	
IVe4a1	moderately coarse	moderately rapid	deep	3 - 6	undulating	none	94
Total							5,745

Findings

Based on the survey, it is concluded that the 3,900 acres in land capability classes I, II, and III are approximately the same as the 3,900 acres of irrigable land for which the Bureau of Reclamation plans to supply irrigation water and which are considered suitable for long-continued cultivation under irrigation.

Table 2 shows how the 3,900 acres of irrigable land are distributed throughout the evaluation areas by land capability units.

Table 2.- Irrigable acreage of land capability units by evaluation areas, Hammond project

Land capability unit	Evaluation area			Total
	A	B	C	
	- - - - - - - - - - Acres - - - - - -			
Ia	4	---	---	4
Ib	223	---	---	223
IIs3a	88	---	---	88
IIe3a	1,011	---	---	1,011
IIe3a1	190	---	---	190
IIs2b	-----	106	---	106
IIs2b1	-----	60	---	60
IIs4a	-----	30	---	30
IIs4a1	-----	26	---	26
IIe3a	-----	480	---	480
IIe3a1	-----	299	---	299
IIe3b	-----	10	---	10
IIIs4	-----	423	---	423
IIIs41	-----	20	---	20
IIIs42	-----	60	---	60
IIIe4	-----	445	---	445
IIIe3a	-----	---	425	425
Total	1,516	1,959	425	3,900

In the following sections of this report, each analytical step used to determine the direct agricultural benefits is presented by evaluation areas. If information were desired regarding basic land conditions, reference should be made to tables 1 and 2.

Irrigation Supplies and Requirements

Sources of Data

Several comprehensive studies were made of irrigation requirements on and in the immediate vicinity of the Hammond project. Among these are: (1) Appendix B of the Record of the Upper Colorado River Basin Compact Commission, (2) A Review of the San Juan Basin Problem in New Mexico by the State Engineer of New Mexico and the New Mexico Interstate Stream Commission, (3) Consumptive Use of Water in the Irrigated Areas of the Upper Colorado River Basin by Blaney and Criddle, and (4) Consumptive Use and Irrigation Water Requirements of Crops in New Mexico by Blaney, Hanson, and Litz. Additional related information is contained in the Water Supply Papers by the U. S. Geological Survey, Climatological Data by the U. S. Weather Bureau, New Mexico Heat and Moisture Indexes for Use in Land Capability Classification by the Soil Conservation Service, and other publications. These and all other available related reports were carefully reviewed for the purpose of this study. In addition, information was liberally supplied by technicians of the Agricultural Research Service, New Mexico College of Agriculture and Mechanic Arts, Bureau of Reclamation, and others familiar with the area.

Analysis of Data

Consumptive use requirements for the principal crops in the area were estimated by the Blaney-Criddle procedures. According to accepted practices, the effective growing season precipitation used is 85 percent of the average of the lowest five-year period of record. Based on probable future crop acreage distribution, the resulting average seasonal consumptive use and water requirements for the project are shown in table 3.

An adequate water supply is expected to be provided for all project lands. No distinction will be made in water deliveries between the evaluation areas. Likewise, there is no essential difference in the total water requirements of these lands. Therefore, the consumptive use estimates and water supply analysis were made on a project-wide basis.

Farm irrigation efficiencies in New Mexico were extensively studied. Present irrigation efficiencies on lands in the vicinity of the project are rather low. It is expected that irrigation efficiencies will be substantially higher under project conditions of a firm and dependable water supply, better water control and changed patterns of water delivery, and increased land development. Facilities were designed for delivery of irrigation streams of a size that will permit efficient application of irrigation water. Development and improvement of project lands were estimated in accordance with recent trends. On the basis of climatic, soil, and water supply conditions and the expected level of development, it is estimated that farm irrigation efficiencies of 55 percent can reasonably be expected.

Table 3.- Consumptive use and water supply requirements, Hammond project

Crop	Net seasonal consumptive use requirements	Projected crop acreage distribution
	Inches	Percent
Alfalfa	25.6	32
Pasture	23.8	27
Corn	15.8	14
Small grain	12.1	14
Orchard	25.4	9
Beans	11.3	4
Project weighted average	21.3	
Estimated average farm losses at 55% average efficiency	17.4	
Estimated water delivery requirement, per productive acre 1/	38.7	
Less water allotted to noncroplands reserved for farmsteads, rights-of-way, etc., estimated at 7% of acreage	2.7	
Estimated net farm delivery requirement, per irrigable acre 2/	36.0	
Project water to be delivered at farm headgate, per irrigable acre	36.2 inches	
Percent of irrigation requirements which will be satisfied	100 percent	

1/ Productive acres are net acres of productive croplands.
2/ Irrigable acres comprise all project lands, including nonproductive areas devoted to farmsteads, road, canal, and ditch rights-of-way and similar nonirrigated areas.

Irrigation water will be obtained from the San Juan River. Natural flow in this stream is quite variable throughout the growing season. Low flows frequently occur during June, July, and August. Many long-established water rights have prior claim to the entire flow during these periods. During the spring snowmelt period the river flow is far in excess of all demands in almost every year.

Construction of Navajo Dam and Reservoir was authorized by the Colorado River Storage Project Act. This reservoir will regulate the flow of the San Juan River and provide carryover storage to equalize water supplies from year to year. Since water for the Hammond project will come from storage in this reservoir, the project will have a dependable water supply.

A tentative reservoir operations study was made by the Bureau of Reclamation, using available records for the years 1928-56, inclusive. This study, with allowances for all presently foreseeable streamflow depletions, indicates that for a series of years comparable to those of the study period, no water shortages would occur.

While existing records indicate the water supply should be adequate, the common experience of irrigation projects is that occasional years of unprecedented deficiency in runoff do occur. These result in water supply shortages of varying degrees of severity, but their occurrence cannot be predicted from the available runoff records.

Advance warning of existing conditions which subsequently develop into a water shortage can be provided by the Snow Survey and Water Supply Forecast Program of the Soil Conservation Service. At the present time, three snow survey courses are operated on the watershed of the San Juan River. These provide a basis for forecasts of inflow to Navajo Reservoir. However, accuracy and reliability of the forecasts would be improved by some extension of the present network. Minimum desirable additions include snow courses and soil moisture measuring stations on the headwaters of the San Juan River at about the 9,000-foot elevation near Wolf Creek Pass in Colorado and near the Continental Divide east and south of Dulce, New Mexico.

Findings

Based on average consumptive use requirements, projected cropping pattern, and attainable farm irrigation efficiencies, it is estimated that the water supply requirements will be fully met by the 36.2 acre-inches of water per acre to be delivered by proposed project facilities. Navajo Reservoir will provide carryover storage from years of excess runoff to years of deficient water supply and will assure adequate seasonal distribution of water.

Land and Irrigation Development

Sources of Data

Considerable land development was accomplished in recent years on lands within and immediately adjacent to the project area. Most of this has been done with assistance from the New Mexico College of Agriculture and Mechanic Arts, San Juan Soil Conservation District, and San Juan County Agricultural Stabilization and Conservation Committee, with technical assistance largely furnished by the Soil Conservation Service. Records of this work were supplied by these agencies. Additional information was gathered from other agencies and technicians working within the area. Some data were obtained from existing maps and surveys and from soil surveys covering the project area. Land development cost estimates are based on the latest price projections available in the Department of Agriculture.

Analysis of Data

Project plans estimate the development of 3,900 acres of irrigable land, including 3,627 acres of productive land and 273 acres of rights-of-way, farmsteads, etc. Development requirements were estimated on the basis of the average level of management that is expected. The primary basis for development requirements was the physical needs of each soil mapping unit, based on comparable work done on similar soil and site conditions within the area. In addition, minimum land development was estimated at the extent necessary for adequate irrigation with the proposed water supply and consistent with the projected level of crop yields.

Land Clearing

Native cover consists of a sparse to moderate growth of sagebrush and associated brushy plants. Estimated costs of land clearing include piling and burning of brush. Since there is little variation in type or density of cover, no distinction is made in this cost item between the evaluation areas, and no rock or stone removal will be required.

Land Leveling

Land leveling is a major expense in land development. It is defined as "the reshaping of the land surface to a planned grade to permit the uniform distribution of irrigation water without erosion, or to provide necessary surface drainage." The operation does not necessarily imply the removal of all slope or gradient from the land surface but, rather, the elimination of surface irregularities which impair the uniform application of irrigation water, or occasionally the terracing of the land to permit irrigation on flatter, transverse slopes.

There are wide variations in the amount of leveling required for the different soil conditions that prevail within the project. Leveling accomplished during the past several years on comparable soils, within and adjacent to the project area, is the basis for estimates.

Farm Irrigation Systems

Farm irrigation systems are required for all project lands. There is little cost information in the area directly applicable to these lands. Basic estimates were developed that are directly related to the requirements imposed by physical limitations of the various soil conditions.

The project area is generally characterized by slopes and soils requiring comparatively high average costs for the development of farm irrigation systems. Considerable lining of farm irrigation ditches will be required to stabilize them against erosion on the steep slopes and, in some cases, to reduce excessive seepage losses. On flatter slopes where unlined ditches may be adequate, check and drop structures will be required at frequent intervals to control water and stabilize the ditch.

Furthermore, due to soil and slope limitations, irrigation runs will have to be comparatively short. This will result in smaller fields and lower land leveling costs but will increase the amount of farm irrigation ditch required for a given acreage. This will also cause some increase in irrigation labor. An allowance for waste water disposal is included in the estimates of development costs.

Drainage

All low-lying lands within the project area are susceptible to damage from seepage. Since aggradation of the bed of the San Juan River is anticipated following completion of Navajo Dam, such lands will, in all probability, become badly seeped with no available outlet for drains. Consequently, they were excluded from the project.

Remaining lands within the project are deep and well drained. It is not expected that drainage problems will occur. The only exception is a small area of fine textured soils bordering the excluded lands where underdrainage from higher lying lands might ultimately become a problem. If this should develop, relief drains can be installed to intercept the underflow. No estimate can be made at this time as to the drainage ditches that would be required or their location.

Provision has been made in project plans for surface drainage. All natural drainageways entering the project will either be diverted into larger channels or will be channeled through the project lands to the river. Existing swales and small channels will provide adequate outlets for surface runoff within the project and for the discharge of irrigation tailwater.

Findings

Most project lands are in native condition and will require full development before they will be suitable for irrigation. Estimated development costs are based on the requirements of each soil mapping unit. Weighted average costs by evaluation areas are summarized in table 4.

Table 4.- Weighted average development costs, Hammond project

Type of improvement	Evaluation area A	Evaluation area B	Evaluation area C
	- - - - - - - - - - Dollars - - - - - - - - - -		
Clearing	6.98	6.98	6.98
Leveling	41.85	64.17	35.57
Irrigation system	18.32	46.76	52.08
Net development cost per irrigable acre	67.15	117.91	94.63

Projected Agricultural Economy

Projections of agricultural incomes and direct agricultural benefits are based on important assumptions about economic and physical conditions. The more significant of these assumptions will be described as the analysis proceeds. The farm budget approach is used for estimates of both incomes and benefits.

Sources of Data

The analysis of potential costs, returns, and income from project land utilized data from four major sources: (1) Findings from other phases of the survey, (2) a survey of farmers in an area on the north side of the San Juan River near Bloomfield, (3) secondary data developed in other areas, and (4) the judgment of numerous informed individuals.

Commodity Price Projections

All price estimates used for evaluating potential incomes, benefits, and associated costs are based upon the latest price projections available in the U. S. Department of Agriculture. These projections are based on "relatively high employment, a trend toward peace, continued population and economic growth, and a stable general price level."

The United States long-term projected index of prices received for all commodities is 235, base period 1910-14. A comparable index is 265 for prices paid, including interest, wages, and taxes. This gives a projected parity ratio of 89, which is about the same as an average of the 1953-55 period. However, prices received have varied somewhat more than prices paid during this period.

Adjustments in the projected prices of commodities for the United States and State of New Mexico were necessary to reflect local conditions, proportions and specific grades of some commodities, and seasonal prices of cash crops. Projected prices of crops, livestock, and livestock products on the Hammond project are shown in table 5.

Table 5.- Long-term projected prices of agricultural commodities, Hammond project

Item	Unit	Price
		Dollars
Alfalfa hay, baled	Ton	22.00
Rotation pasture	AUM	6.50
Barley	Bu.	1.10
Corn silage	Ton	7.50
Corn grain	Bu.	1.50
Beans	Cwt.	1/ 5.70
Apples	Bu.	1/ 1.85
Market milk (b.f.) 2/	Lb.	1/ 1.21
Grade-A	Lb.	1/ 1.40
Grade-C	Lb.	1/ .76
Cull dairy cows (1,200 lbs.)	Lb.	.10
Cull beef cows (1,000 lbs.)	Lb.	.12
Grass-fat steers	Lb.	.19
Grass-fat heifers	Lb.	.18
Cull ewes	Lb.	.07
Lambs	Lb.	.20
Wool	Lb.	.47

1/ Net prices received by farmers.
2/ Weighted average includes 70 percent grade-A and 30 percent grade-C at 3.5 test.

Based upon the latest price projections available in the U. S. Department of Agriculture.

Anticipated Crop Yields

Crop yields were estimated by evaluation areas (table 6). Yield estimates with project conditions in evaluation areas A, B, and C were based on yields obtained on comparable irrigated areas and other pertinent crop yield data. Projected yields are based on an assumption of average management.

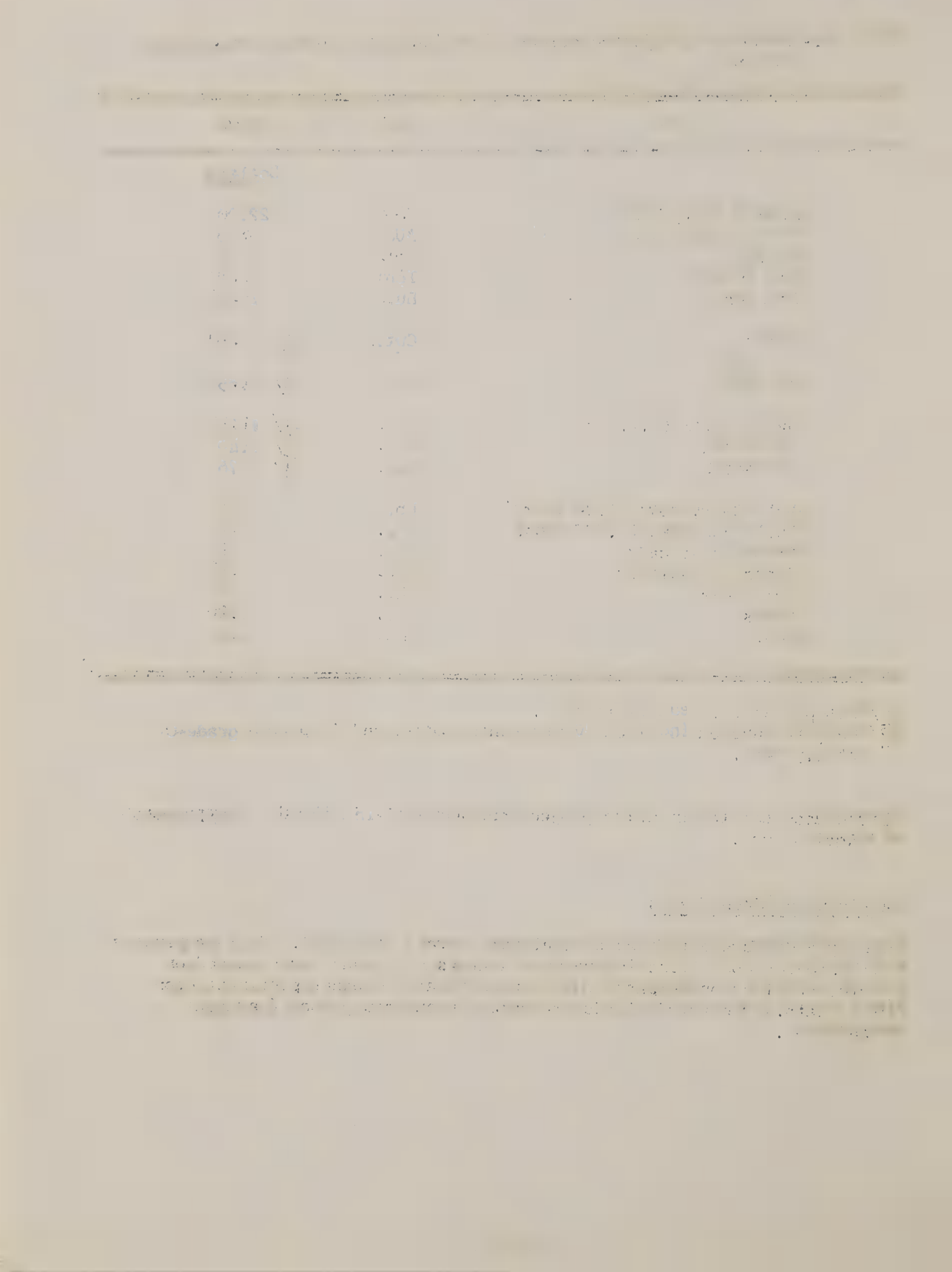


Table 6.- Projected crop yields 1/ by evaluation areas, Hammond project

Crop	Unit	Evaluation areas (with project)		
		A	B	C
Alfalfa hay 2/	Ton	4.4	4.0	3.6
Rotation pasture 3/	AUM	8.5	7.5	6.5
Barley 4/	Bu.	50.0	45.0	-----
Corn silage	Ton	16.0	14.0	-----
Corn grain	Bu.	70.0	65.0	-----
Dry beans 5/	Cwt.	16.0	14.0	-----
Apples 6/	Bu.	----	----	5/ 350.0

1/ Yields of forage and grain are reduced 7 and 2 percent, respectively, for shrinkage and feeding in computing available feed for livestock.
2/ Fertilizer: 75 lbs. P_2O_5 applied annually and 40 lbs. N applied at seeding time on nurse crop, or equivalent manure per acre.
3/ Fertilizer: 45 lbs. P_2O_5 and 33½ lbs. N, or equivalent manure per acre annually.
4/ Grown as nurse crop only.
5/ Marketable product.
6/ Fertilizer: 25 lbs. P_2O_5 and 45 lbs. N, or equivalent manure per acre annually.

Livestock Enterprises and Production Rates

The proposed acreages for grade-A dairies would supply sufficient feed for 33 to 35 cows and their replacements. On the sheep farms 373 to 385 mature ewes would be furnished feed from the farm. Beef cattle will receive part of their feed from federal grazing permits which are limited to about 600 cows. Additional feed will have to be purchased to maintain the beef cattle.

Turnoff rates for livestock are shown in table 7. They include production of 300 pounds of butterfat per grade-A dairy cow, 460 pounds of grass-fat, long yearling per beef cow, and 83 pounds of grass-fat lamb and 10 pounds of wool per mature ewe.

Table 7.- Estimated turnoff rates per 100 head of breeding livestock, Hammond project

Livestock	Beginning inventory	Born	Died	Annual turnoff			Ending inventory
				Number	Weight: Lbs.	Total: Lbs.	
Dairy:							
Cows							
(2 yrs. and over)	100	---	3	14	1,200	16,800	100
Heifers							
(1 yr. and over)	25	---	-	8	-----	------	25
Heifers							
(under 1 yr.)	26	---	1	---	-----	------	26
Calves	---	90	5	1/ 59	-----	------	---
Butterfat (3.5 test)	---	---	-	100	300	30,000	---
Beef:							
Cows	100	---	3	16	1,000	16,000	100
Replacements 2/	19	---	-	---	-----	------	19
Long yearlings 3/	82	---	3	60	767	46,000	82
Calves	---	85	3	---	-----	------	---
Bulls	4	---	-	---	-----	------	4
Sheep:							
Ewes	100	---	8	12	135	1,620	100
Replacements	21	---	1	---	-----	------	21
Lambs	---	4/120	7	92	90	8,280	---
Rams	3	---	-	---	-----	------	3
Wool	---	---	-	124	10	1,240	---

1/ Nonreplacement calves will be sold soon after birth.
2/ Heifers will be bred to calve at 3 years.
3/ Nonreplacement long yearlings sold as grass-fats.
4/ Number at docking time.

Anticipated Types and Sizes of Farms and Present Land Tenure

Anticipated types of farms with project development are based upon future markets for each agricultural commodity, present farming operations with adequate water supplies, available federal grazing permits, and opinions of local agricultural leaders. Livestock is expected to be the predominant enterprise on the project because it offers the most stable economy. Cash crops offer an alternative income opportunity for some farmers but are subject to greater fluctuations in income.

A comparable area, Bloomfield, was used as a guide in projecting farm size for the Hammond project. Types of full-time farms in the Bloomfield area in order of importance are cash-crop, fruit-general, fruit-beef, and fruit-sheep. The range in size is from 40 to 180 irrigable acres.

Within the area which will be served with irrigation water on the Hammond project, there are 47 ownerships ranging in size from 10 to 370 acres. Most ownerships are within three size ranges of 10 to 45 acres, 80 to 115 acres, and 150 to 165 acres. Three ownerships exceed 190 acres.

A brief description of each anticipated farm type follows.

Fruit - Farms of 30 to 40 acres devoted principally to the production of apples. Farms would be located on the steeper slopes with good air drainage. This type would occupy about 11 percent of the irrigable acreage. The family would not be employed the entire year.

Grade-A Dairy - Acreage varies from 80 to 95 acres per farm and would comprise 31 percent of the irrigable acreage. Grade-A milk would be the principal product, and the family would have full-time employment.

Cash Crops - All crops produced (alfalfa, corn for grain, and dry beans) are assumed to be sold. These farms are among the largest in acreage ranging from 120 to 140 acres and account for 28 percent of the total irrigable acreage. The family would not be fully employed the entire year.

Breeding Beef Cattle - Part of the feed supply is furnished by federal range which limits the number of farms to six 100-cow herds or equivalent. Sale of grass-fat long yearlings provides principal income. Farms of this type average 120 to 140 acres and would comprise 20 percent of the irrigable acreage. The farm family would be employed most of the year.

Farm Flock of Sheep - Principal returns from this type would be from the sale of grass-fat lambs and wool. This type would approximate 10 percent of the irrigable acreage and average 120 to 140 acres per farm. The number of farms assumed in this type is less than other types. The family would be employed most of the year.

Anticipated Cropping Systems and Management Practices

Present land use obtained in the adjacent farm area in 1956 showed the following percentages: alfalfa, 44; pasture, 8; barley, 13; dry beans, 10; corn for grain, 6; corn silage, 1; apples, 9; other crops, 3; and farmstead, etc., 6.

Essentially the same crops are expected to be grown on the Hammond project, but in different proportions. The anticipated larger proportion of livestock farms will require larger pasture and corn silage acreages and smaller acreages for alfalfa, corn for grain, and dry beans. The acreage of corn silage is expected to be greater than the combined acreage of corn for grain and dry beans. Corn for grain and dry beans are expected to occupy equal importance in the cropping pattern, even though in some years one may comprise a larger acreage than the other due to market demand. It is assumed that acreages of the above crops amount to the same proportions for evaluation areas A and B (table 8).

Evaluation area C will be devoted primarily to fruit production because of good air drainage, soils, climate, and markets. Pasture will be used in crop rotation with fruit. Roman Beauty and Golden Delicious are the most popular apple varieties and are anticipated to be grown in the future. These varieties yield higher, sell for more, are harvested at different times, and bloom for a longer period which reduces risk from frost. The apple acreage on the Hammond project is expected to be about 8 percent of the total acreage.

Table 8.- Projected cropping pattern by evaluation areas, Hammond project

Crop	Evaluation area			Total
	A	B	C	
	- - - - - - - - - -	Acres	- - - - - - - - - -	
Alfalfa	506	653	---	1,159
Rotation pasture	390	504	79	973
Barley	224	290	---	514
Corn silage	160	207	---	367
Corn grain	65	84	---	149
Dry beans	65	84	---	149
Apples	---	---	316	316
Farmstead, etc.	106	137	30	273
Totals	1,516	1,959	425	3,900

A six-year crop rotation is expected on livestock farms, four years of alfalfa or pasture, one year of corn silage, and one year of barley as a nurse crop. Cash-crop farms will have four years of alfalfa and one year each of corn for grain, dry beans, and barley as a nurse crop. These rotations apply to evaluation areas A and B. The apple cycle would include 9 years as nonbearing, 27 years as bearing, and 9 years in pasture.

Returns to Operator and Family Labor and Management

An appraisal of the adequacy of projected farm incomes requires a guide or standard in terms of return to operator and family management and labor. For purposes of this report, a return of $3,100 is suggested as an average for full-time farms. Variations from this amount would be expected with different managerial requirements and quantities of operator and family labor.

An opportunity-cost approach has been used as the basis of the return to management and labor. Thus, operator and family management and labor are evaluated in the same manner as other resources utilized on the irrigated farms.

In addition to return for management and labor, the farm family will have a return on its equity in the farm. Returns on investment owned by the operator and returns for management and labor must provide for cash living expenses, farm privileges (considered as farm income), a residence, savings, income tax, social security tax, and other living needs.

The labor standard applied in the projected budgets is 3,000 hours of operator labor and 1,500 hours of family labor annually, plus the necessary management. A further limitation during summer months is 280 hours per month for the operator and 140 hours per month for the family. Variations from this standard of 4,500 hours occur because of differences in types and sizes of farms. Only the dairy farms approach this magnitude of labor needs on the Hammond project.

Original investigation of this problem has not been feasible. Reliance is placed on previous work, mainly the conclusions of the study of the Weber Basin Reclamation Project in Utah and investigations which served as a basis for those conclusions.1/ That study arrived at an allocation to labor and management of $1,800 at 1939-44 adjusted prices and $2,600 at the U. S. Department of Agriculture 1952 projected prices (215 indexes, parity 100). This latter conversion was made using indexes of prices paid for living items used in family maintenance. These incomes gave the operator a farm-hired wage rate for his labor and a somewhat smaller return for family labor based on a man-equivalent. The method used in the Weber Basin study results in an allocation to labor and management of $3,186. This figure has been adjusted to $3,100 for the Hammond project.

Local inquiries have been made in connection with the Upper Colorado River Basin survey. Expenditures for family living have been obtained from records of the Farmers Home Administration. Reports on special studies have also been utilized. A general observation is that the standard set for the Hammond project in terms of funds available for family living is greater than average current expenditures by farm families in the vicinity of the Hammond project. This result is to be expected since projections for the Hammond project are oriented to an improved agricultural economy.

1/ Fuhriman, W. U., Blanch, G. T., and Stewart, C. E., An Economic Analysis of the Agricultural Potentials of the Weber Basin Reclamation Project, Utah. Utah Agricultural Experiment Station Special Report No. 7, December 1952.

Projected Agricultural Incomes and Direct Benefits

Two general, related objectives are essential for the economic analysis. One is to estimate farm and family incomes with the proposed water development with various combinations of resource control and use. This serves as a basis for achieving the second objective and for appraising the prospects for a successful, stable, irrigated agriculture under the proposed water development. The second objective is to estimate the direct agricultural benefits expected from project development.

Projected Agricultural Incomes

The economic analysis is based throughout on projected farm budgets. Farm budgets require many kinds of input-output and price information. Labor requirements, machinery and building needs, land investment, feed requirements and other data are needed. Research in similar irrigated areas has been heavily relied upon for this information. It has been supplemented by information obtained locally. Prices received and expense rates were also obtained in the Hammond area.

Typical farm budgets are used to estimate net incomes on the basis of projected prices and other assumptions of future conditions for each evaluation area. These net incomes are then aggregated on the basis of total acreages to derive an estimate of agricultural incomes expected from development of water on the Hammond project. Some details of several projected budgets can be observed in table 9.

Farms in evaluation area A are assumed to have the same crop rotation and cropping pattern as those in evaluation area B. Larger farm acreages are used in the budgets for evaluation area B than for evaluation area A because anticipated per-acre production is lower. This practice is customarily applied in federal reclamation programs. The national policy on new projects is to give settlers approximately equal opportunity.

Farms of evaluation area B are slightly larger in every respect than those in evaluation area A. This relationship holds for total investment, exclusive of land, with a range from $11,000 on cash-crop farms to $30,000 on beef farms. Beef farms have the largest investment in livestock while grade-A dairy farms lead in machinery, buildings, and improvements. The averages shown in table 9 are based on 35 percent of the land in dairy farms, 32 percent in cash-crop farms, 22 percent in beef farms, and 11 percent in sheep farms in evaluation areas A and B.

Total receipts average over $11,000 per farm in each of evaluation areas A and B. Grade-A dairy farms exceed $13,000 while sheep farms are about $9,000. Farm expenses (exclusive of interest, land and water development, and annual operation and maintenance costs) range from about $4,000 on sheep farms to about $5,000 on grade-A dairy farms.

Net farm income on evaluation area B at $6,941 averages $128 greater than net farm income on evaluation area A. Grade-A dairy farms have about $3,000 larger net farm income than sheep farms. This income difference is largely attributable to the fact that the dairy farms have a much larger investment and utilize substantially greater amounts of operator and family labor. Net incomes from beef herds would be reduced considerably if public rangeland were not included.

Table 9.- Projected agricultural incomes after farm development and selected sizes and organizational items for farm budgets by evaluation areas, Hammond project

Item	Unit	Evaluation area A					Evaluation area B					Evaluation area C	Project
		Grade-A dairy	Cash crops	Beef herd	Farm flock sheep	Weighted average	Grade-A dairy	Cash crops	Beef herd	Farm flock sheep	Weighted average	Fruit (apples)	Weighted average
Weighting	Percent	35	32	22	11	------	35	32	22	11	------	100	------
Total land	Acres	80	120	120	120	106	95	140	140	140	124	32	107
Forage	Acres	62	64	93	95	73	74	73	108	110	85	6	------
Grain	Acres	12	32	19	17	21	14	38	22	20	24	1/ 18	------
Beans	Acres	------	16	------	------	5	------	19	------	------	6	2/ 6	------
Farmstead, etc.	Acres	6	8	8	8	7	7	10	10	10	9	2	------
Productive livestock	Number	33	------	100	373	------	35	------	100	385	------	------	------
Total labor	Hours	4,383	1,932	3,127	2,789	3,147	4,907	2,472	3,538	3,263	3,646	2,982	3,378
Operator & family	Hours	4,038	1,836	3,023	2,696	2,962	4,248	2,278	3,397	3,058	3,299	2,316	3,059
Total tractor use	Hours	483	796	839	710	686	579	987	950	835	819	329	713
Farm tractor	Hours	441	724	773	651	628	530	903	873	765	751	305	654
Total investment 3/	Dollars	27,534	11,251	30,421	18,103	21,921	28,581	11,448	30,509	18,541	22,418	13,345	21,226
Bldg. & improvements	Dollars	5,622	2,660	3,090	3,414	3,874	5,703	2,730	3,180	3,558	3,961	2,055	------
Machinery	Dollars	8,580	6,411	6,702	6,763	7,273	8,580	6,411	6,702	6,763	7,273	4,143	------
Livestock	Dollars	12,300	------	19,050	6,388	9,199	13,200	------	19,050	6,617	9,538	------	------
Other	Dollars	1,032	2,180	1,579	1,538	1,575	1,098	2,307	1,577	1,603	1,646	4/ 7,147	------
Total receipts	Dollars	13,165	10,169	11,733	9,294	11,465	14,057	10,700	11,771	9,603	11,990	12,205	11,809
Crop sales	Dollars	93	10,069	993	451	3,523	84	10,600	1,031	485	3,702	12,105	------
Livestock & products	Dollars	12,851	------	10,640	8,743	7,800	13,752	------	10,640	9,018	8,146	------	------
Other	Dollars	221	100	100	100	142	221	100	100	100	142	100	------
Total farm expenses 5/	Dollars	4,979	4,124	5,180	4,089	4,652	5,586	4,585	5,182	4,425	5,049	5,503	4,944
Net farm income	Dollars	8,186	6,045	6,553	5,205	6,813	8,471	6,115	6,589	5,178	6,941	6,702	6,865
Interest 6/	Dollars	1,377	563	1,521	905	1,096	1,429	572	1,525	927	1,121	667	1,061
Net income 7/	Dollars	6,809	5,482	5,032	4,300	5,717	7,042	5,543	5,064	4,251	5,820	6,035	5,804

1/ Bearing fruit.
2/ Nonbearing fruit.
3/ Excluding land investment
4/ Includes $7,035 orchard investment.
5/ Excluding interest, land and water development, and O & M.
6/ At 5 percent.
7/ Return to operator and family labor and management, land and water.

Based upon the latest price projections available in the U. S. Department of Agriculture.

USDA-SCS-PORTLAND OREG.-1967 M-1881

Interest on investment at 5 percent amounts to about $1,000 for evaluation areas A and B. If interest on investment and $3,100 for operator and family labor and management were deducted, about $2,700 remain as return to land and water, including related water costs.

The fruit-type farm has 32 acres compared with 106 acres for evaluation area A and 124 acres for evaluation area B. Investment per fruit farm is only slightly more than half the average investment in other types of farms, exclusive of land and water. Both receipts and expenses are slightly larger than averages of evaluation areas A and B. Net farm income is $6,702, or about the same as the other evaluation areas. With interest on investment of $667, net income amounts to $6,035. An allowance of $3,100 for operator and family labor and management leaves $2,935 as return to land and water, including related water costs.

For the project, the per-farm weighted averages are as follows: Total land, 107 acres; total investment, $21,226; total receipts, $11,809; expenses, $4,944; net farm income, $6,865; and interest on investment, $1,061. This leaves a net income of $5,804 as return to land and water including related water costs. These weighted averages were based on 1,516, 1,959, and 425 irrigable acres in evaluation areas A, B, and C, respectively.

Findings

Net farm incomes based on the projected budgets, with the development of an adequate irrigation water supply, would provide a good level of living to farmers on the proposed Hammond project. The weighted average of net farm incomes is $6,865 per farm. After allocating interest on investment, other than land, $5,804 remain for family and operator labor and management, investment in land and irrigation water, and annual payment of related water costs.

Direct Agricultural Benefits

The primary objective of the analysis is to estimate direct agricultural benefits. These benefits are defined as the value of farm production expected with project development in excess of the value of nonproject resources required in the development and operation of project farms. The concepts and assumptions on the specific composition and value of nonproject resources or associated costs, as used in this report, are outlined below.

A basic assumption is that the national economy will operate at essentially full employment for the period of analysis. Based on this general assumption, alternative employment opportunities would be expected in the national economy for resources used in the development and operation of irrigated farms, including the labor and management skills of farm operators. Also, the projected levels of farm prices received and paid are higher than they would be with a significant amount of unemployment.

The estimate of direct agricultural benefits is made on the basis of the budgets presented in the preceding section. However, in the evaluation of benefits and associated costs, the costs and returns of livestock enterprises are not included. The level of net benefits that results from this type of analysis is generally comparable to the combined results of a number of complete farm budgets. The results from this type of analysis are much more uniform and stable between different farm types. This approach tends to avoid the problem of making proper cost allowances for the different levels of management and different quantities of operator and family labor required for different types of farms.

The cropping patterns assumed in the analysis, however, are the same as used in the analysis of potential farm incomes and thus reflect the need for pasture, hay, and other feed crops in livestock enterprises. Also, the prices for hay and pasture in the analysis are based upon their value in livestock enterprises.

Table 10 shows the value of crop production and annual production costs by evaluation areas. Incomes on cash-crop and fruit budgets are the same as those in the income analysis (table 9).

Operator and family labor for all farm plans average 1,334 hours for evaluation area A, 1,722 hours for evaluation area B, and 2,316 hours for evaluation area C (table 10). A rate of $1.15 per hour for operator and family labor and management is used in this analysis.

The weighted incomes per acre for evaluation areas A, B, and C are $21.81, $15.33, and $105.38, respectively, after deducting for cost of family and operator labor (table 10). Annual amortized cost of farm irrigation system and land development has not been deducted from these figures. However, an annual replacement charge for orchards was included in expenses for fruit budgets.

Table 10.- Weighted average value of production and annual production costs for projected farm budgets on the basis of crop sales only, by evaluation areas, Hammond project 1/

Item	Unit	Evaluation area								
		A				B				C
		Grade-A dairy	Beef and sheep	Cash crops	Weighted average	Grade-A dairy	Beef and sheep	Cash crops	Weighted average	Fruit (apples)
Weighting	Percent	35	33	32	-----	35	33	32	-----	100
Irrigable land	Acres	80	120	120	106	95	140	140	124	32
Operator and family labor	Hours	887	1,321	1,836	1,334	1,195	1,742	2,278	1,722	2,316
Investment 2/	Dollars	9,440	10,100	11,260	10,240	9,580	10,240	11,440	10,400	3/13,345
Receipts	Dollars	5,778	8,713	10,169	8,151	6,118	9,014	10,700	8,540	12,205
Expenses 3/	Dollars	3,089	3,932	4,124	3,698	3,349	4,263	4,585	4,046	5,503
Net farm income	Dollars	2,689	4,781	6,045	4,453	2,769	4,751	6,115	4,494	6,702
Interest 4/	Dollars	472	505	563	512	479	512	572	520	667
Net income	Dollars	2,217	4,276	5,482	3,941	2,290	4,239	5,543	3,974	6,035
Operator and family labor cost 5/	Dollars	1,020	1,519	2,111	1,534	1,374	2,003	2,620	1,980	2,663
Income, total	Dollars	1,197	2,757	3,371	2,407	916	2,236	2,923	1,994	3,372
Income, per acre	Dollars	14.96	22.98	28.09	21.81	9.64	15.97	20.88	15.33	105.38

1/ For analytical purposes, livestock with associated costs and returns and public rangeland have been omitted.
2/ Exclusive of land.
3/ Excluding interest, land and water development, and O & M.
4/ At 5 percent.
5/ At $1.15 per hour.

Based upon the latest price projections available in the U. S. Department of Agriculture.

Land Investment Associated With the Project

The acreage for each evaluation area, appraised value of dryland, investment in land development and farm irrigation system, and annual cost per acre are shown in table 11. Costs of farm buildings, fences, domestic water, and maintenance and repair costs for the irrigation system are included as farm expenses in the farm budgets (tables 9 and 10). Man and machine labor and cost requirements have been aligned with the degree of land development and farm irrigation system for each evaluation area.

Projected investments per irrigable acre of the above items for evaluation areas A, B, and C are $70.15, $120.91, and $97.63, respectively, (table 11). Annual amortized costs per acre at 5 percent are $3.61, $6.30, and $5.14.

Table 11.- Estimated weighted average annual cost per acre of irrigable land for land development and farm irrigation system, by evaluation areas, Hammond project

Item	Unit	Evaluation area		
		A	B	C
Land area	Acres	1,516	1,959	425
Capital Investment				
Irrigable land value 1/	Dollars	3.00	3.00	3.00
Land clearing	Dollars	6.98	6.98	6.98
Land leveling	Dollars	41.85	64.17	35.57
Total land investment	Dollars	51.83	74.15	45.55
Annual cost 2/	Dollars	2.61	3.74	2.29
Farm irrigation system	Dollars	18.32	46.76	52.08
Annual cost 3/	Dollars	1.00	2.56	2.85
Total annual cost	Dollars	3.61	6.30	5.14

1/ Appraised value of dryland.
2/ Amortized over a 100-year period at 5 percent interest (factor .05038).
3/ Amortized over a 50-year period at 5 percent interest (factor .05478). Cost of maintenance and repair included in farm budgets.

The Development Period

Historically, several years have been necessary to achieve full development of land on new irrigation projects. In turn, a lag always occurs before agricultural incomes and project benefits are at a level associated with an established agricultural economy. On some projects, only 2 or 3 years have been necessary; on others, a much longer period has been required. This lag is recognized by federal reclamation legislation by permitting a development period up to 10 years before repayment charges are levied on the farms.

The assumption is made for the Hammond project that a period of 10 years will elapse, after water is available, before the average level of estimated benefits will be achieved, except for fruit-type farms which will require 18 years. These periods are used for discounting purposes.

Irrigated farming and development of a new farm require considerable capital, labor, and management. Difficulties in farm development are primarily the result of capital limitations. Farmers have demonstrated, in recent years on several projects, that good production rates can be achieved within 2 or 3 years provided the resources, especially capital, are available to develop the land and to obtain the necessary equipment, livestock, and buildings.

Total new capital needs on many farms expected on the Hammond project will exceed $50,000 per farm (table 12). For example, the grade-A dairy farm with only 80 acres approaches $52,000 in total capital needs. The minimum for the illustrative farms is $33,533 for the cash-crop farm. These figures include a residence. A stable agricultural economy will require satisfactory living conditions for farm families. However, an adequate residence often must be delayed until most of the farm capital needs are met.

It is evident that development of the Hammond project will require large quantities of farm capital. These needs may pose serious public and individual problems.

Table 12.- New capital investment for several illustrative farms, by evaluation areas, Hammond project

Item	Dairy	Cash crops	Beef
Evaluation area	A	A	B
Acres	80	120	140
	Dollars	Dollars	Dollars
Land	5,612	8,418	16,927
Farm buildings	9,370	4,433	5,300
Equipment	14,299	10,682	11,168
Livestock 1/	12,300	------	19,050
Total farm	41,581	23,533	52,445
Residence 2/	10,000	10,000	10,000
Total needs	51,581	33,533	62,445

1/ Livestock could be produced partly on the farm, but this process of building a herd is slow.
2/ Value assumed for illustrative purposes.

Based upon the latest price projections available in the U. S. Department of Agriculture.

Summary of Annual Direct Benefits

Table 13 summarizes the net value of agricultural products, annual amortized cost of farm irrigation system and land development, and gross and net direct benefits on a per-acre and total basis by evaluation areas. Weighted averages for the project are also shown for each of the above items.

Average gross direct benefits amount to $18.20 per acre for evaluation area A, $9.03 per acre for evaluation area B, and $100.24 per acre for evaluation area C.

A discount factor is applied to gross direct benefits to ascertain the net direct benefits. This discount factor is contingent on the development or waiting period necessary for full realization of the projected production and incomes for the project. A 10-year development period is assumed, except for fruit farms which require 18 years for full benefits. The interest rate is 5 percent and the evaluation period is 100 years.

The present annual equivalent value of direct benefits is $14.73, $7.31, and $64.53 per acre for evaluation areas A, B, and C, respectively, (table 13). The weighted average for the entire 3,900 acres is $16.43 per acre, or about $64,000 annually.

Findings

Direct benefits to irrigation water are calculated on the basis of farm budgets. For analytical purposes, livestock and associated incomes are omitted. This approach eliminates an income and benefit problem related to processing feed through livestock enterprises and allocating returns to the appropriate resources. Operator and family labor and management are evaluated in the same manner as other resources.

The residual approach is used to estimate direct agricultural benefits from irrigation water. The total income is allocated among various claimants, with water being the last claimant in terms of a return.

In view of the above procedure, direct benefits amount to $14.73, $7.31, and $64.53 per acre for evaluation areas A, B, and C, respectively.

Weighted average direct benefits for the entire 3,900 irrigable acres in the Hammond project amount to $16.43 per acre, or a total of about $64,000 annually.

Table 13.- Summary of expected annual direct benefits and associated development costs, by evaluation areas, Hammond project

Evaluation areas	Land area	Net value of agricultural products		Annual amortized cost of land development and investment		Gross direct benefits		Discount factor 1/	Net direct benefits	
		Per acre	Total	Per acre	Total	Per acre	Total		Per acre	Total
	Acres	---------- Dollars ----------							---- Dollars ----	
A	1,516	21.81	33,064	3.61	5,473	18.20	27,591	2/ .80927	14.73	22,329
B	1,959	15.33	30,031	6.30	12,342	9.03	17,689	2/ .80927	7.31	14,315
C	425	105.38	44,786	5.14	2,184	100.24	42,602	3/ .64372	64.53	27,424
Project	3,900	27.66	107,881	5.13	19,999	22.53	87,882	------	16.43	64,068

1/ At 5 percent amortized over a 100-year evaluation period.
2/ Assumes a 10-year development period.
3/ Assumes 18 years prior to attaining full benefits.

CHAPTER III

IMPACT OF THE HAMMOND PROJECT UPON NATIONAL FOREST, OTHER FOREST LANDS, AND UPON FOREST RESOURCES

No national forests or nonfederal forests are located within the project area.

Some 30 miles separate the Carson National Forest from the nearest project installations, and there will be no foreseeable impacts upon national forest administration, management, and use.

It appears that nonfederal forest land will be similarly unaffected by project installation and operation.

CHAPTER IV

THE RELATIONSHIP OF WATERSHED CONDITIONS TO THE HAMMOND PROJECT

Watershed conditions covered in this report are common to most irrigation projects. They do not materially affect feasibility of the project. However, improvements of watershed conditions will extend the life of the project and reduce operating difficulties and maintenance expenses. They are pointed out here so that local, state, and federal agencies dealing with watershed lands can orient their regular and special programs to the improvement of watershed conditions.

Location and Size

The watershed that directly affects the Hammond project includes those tributaries of the San Juan River between the site of Navajo Dam and the Hammond project diversion and those drainages that cross project lands. Almost all of the lands contributing runoff to these drainages are located in New Mexico. A small mesa comprising the headwaters of the Pump drainage extends across the state line into Colorado. All of these lands are located in San Juan, Rio Arriba, and Sandoval Counties, New Mexico and La Plata County, Colorado.

Subwatersheds

The major drainages considered in this watershed report are:

	Square miles
Pump	145
Gobernador	115
Largo	1,795
Munoz	15
Armenta	25
Kutz	60
Horn	10
Gallegos	350
Manzanares	10
Numerous small un-named drainages	75
Total	2,600

Pump and Gobernador drainages discharge into the San Juan River above the site of the Hammond project diversion. Other drainages discharge into the river below the diversion after passing through project lands. The main supply canal will cross all of these latter drainages.

HAMMOND PROJECT WATERSHED

SANDOVAL, RIO ARRIBA, & SAN JUAN COUNTIES, NEW MEXICO
and LA PLATA COUNTY, COLORADO

SEPTEMBER 1957

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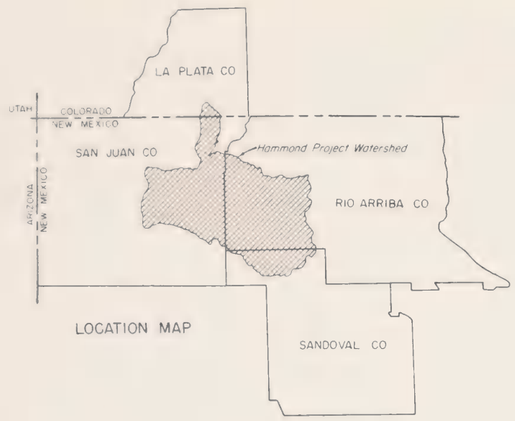
SCALE IN MILES



LOCATION MAP

LEGEND

- Watershed Boundary
- Sub Watershed Boundary
- Approximate Location Of Highline Canal
- Critical Areas
- Sterile Shale Areas

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Watershed Characteristics

Topography and Geology

All but one of the main drainages originate in the high eastern and southern parts of the watershed and flow in a northwesterly direction to the San Juan River. Pump Canyon is the only major drainage entering the river from the north side.

Elevation in the watershed ranges from 5,500 to 7,500 feet. At the lower elevations the San Juan Valley is flanked by moderately steep, gravel hills which graduate into more uniform, moderate slopes at midelevation. The high elevation is characterized by rough, broken topography.

Mesas of various sizes with steep sandstone escarpments dominate the watershed. Drainage origins in the eastern part of the watershed have a mountainous topography in contrast to the southern drainage origins which are rough and moderately hilly. The small drainages merge at intermediate and lower elevations to form major tributaries of the San Juan River.

Geologic materials of the watershed are principally sandstone and shale. The dominant geologic material is a sandstone member of the Wasatch formation. Below the Wasatch formation are sandstone and shale members of the Torregon and Puerco formations of the Nacimiento group. Valley floors are primarily alluvium from shale material while the arroyo beds are generally sandy.

Soils and Erosion

Residual soils have developed from weathered sandstone and shale. Those suitable for irrigation have developed from Tocita sandstone or interbedded sandstone and shale of the Mesa Verde formation. Most of the mesas have shallow, sandy, residual soils influenced by wind erosion. The valley floors are generally deep, fine textured alluvium from shale material. These soils are low in organic matter, but fertility is adequate to produce good range forage under average moisture. The badlands area consists of sterile shales that erode easily and produce large amounts of sediment.

Sparse vegetation and moderate to severe soil erosion over the entire watershed are a result of arid climate, highly erodible soils, steep slopes, and past misuse. Sediment is produced at a rapid rate and valley fills are deeply gullied. Wind erosion is active as a result of the sparse vegetation.

Precipitation and Runoff

Precipitation over the lower watershed varies from 8 to 14 inches or more annually. Higher areas receive 14 inches or more of precipitation, principally snow.

Pump and Gobernador are the only subwatersheds that have high elevation areas. Runoff from these high elevations occurs mainly during two periods of the year: (1) The normal spring runoff from melting snow and spring rains, and (2) runoff from occasional summer cloudbursts during July, August, and September.

The majority of the watershed is at the lower elevation. Here intermittent summer rains produce runoff which collects rapidly in channels after storms. Part of the flows are absorbed by the dry channels. Occasionally large volumes of sediment reach the San Juan River and remain in the riverbed until main stem floods carry it downstream.

Vegetation

Vegetative cover over the watershed is typical of the Upper Sonoran-Colorado River Plateau country. Pinon-Juniper, Big Sagebrush, and grass are the dominant cover types with Chamise and Oakbrush being of minor importance. Ponderosa Pine and Scrub Oak are prominent at upper altitudinal limits.

Cover types	Percent
Pinon-Juniper	30
Big Sagebrush	54
Open grassland	15
Ponderosa Pine	1
Oakbrush	trace

These cover types occur in an intermixed pattern over much of the watershed. Vegetative cover on the watershed is sparse due to low rainfall, infertile soils, steep slopes, and past use.

Inadequate number and distribution of stock water facilities have contributed to poor vegetative cover. Reduction of numbers and better distribution of livestock is underway now by most landowners and land-administering agencies. Due to natural, unfavorable growing conditions, it will be a long time before improvement of vegetative cover will affect yield of runoff or sediment.

Land Use

The lands in the watershed are used for grazing, and very little land is cultivated other than the river bottomland. The land is adapted to winter use, principally by sheep. Big Sagebrush, Chamise, and other browse species provide emergency forage in times of stress during winter months. A large percentage of the land used for grazing purposes is public domain administered by the Bureau of Land Management. Other lands, including patented, national forest, Indian allotments, and state land, are similarly used for grazing purposes. These lands, used by Indian and non-Indian licensed operators, are classified as follows:

Table 14.- Grazing use of watershed lands, Hammond project

Type of operator	Using watershed lands between point of diversion and Navajo Dam		Using watershed lands between point of diversion and below		Total	
	Operator	Animal units	Operator	Animal units	Operator	Animal units
	Number					
Individual operators:						
Non-Indian	30	2,430	35	5,094	65	7,524
Indian	--	-----	2	161	2	161
Indian (Jicarilla Apache)	--	-----	17	4,970	17	4,970
Community operators:						
Non-Indian	47	250	4	322	51	572
Indian	--	-----	177	1,156	177	1,156
Forest permits	--	-----	8	300	8	300
Total	77	2,680	243	12,003	320	14,683

Watershed lands are used by the Indian operators for yearlong grazing. The community non-Indian operators ordinarily use the lands during the spring-summer-fall period, while most of the non-Indian individual operators make winter use of the rangelands. A total of 14,683 animal units is grazed on these watershed lands. The development of the Hammond project would not have an adverse effect on the grazing operation of the present range users since only small amounts of grazing land would be within the project.

Table 15.- Land ownership and status, Hammond project watershed

Class of ownership	Area	Percent of total
	Square miles	
Private land	320	12
State land	120	5
Federal land:		
National forest	65	3
Public domain	1,130	43
Indian	965	37
Total	2,600	100

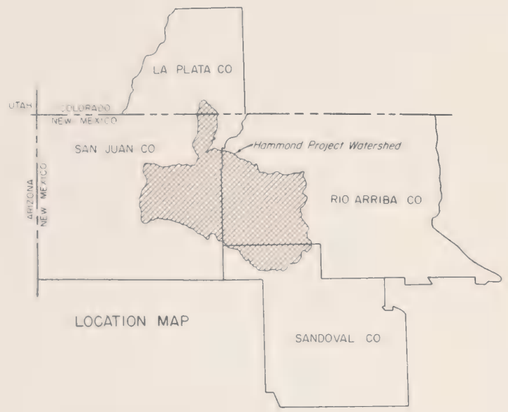
LAND STATUS

HAMMOND PROJECT WATERSHED

SANDOVAL, RIO ARRIBA, & SAN JUAN COUNTIES, NEW MEXICO
and LA PLATA COUNTY, COLORADO

SEPTEMBER 1957

SCALE IN MILES



LOCATION MAP

LEGEND

- P — Private Lands
- V — Public Lands
- I — Indian Lands
- F — National Forest Lands
- S — State Lands

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Watershed Problems

The Navajo Dam will create a storage reservoir to regulate the flow of the San Juan River above the Hammond project. Runoff and sediment from the watershed of the San Juan River above Navajo Dam will be controlled by the dam and will have no adverse effect on the Hammond project. Uncontrolled floodflows and sediment from Pump and Gobernador Canyons will adversely affect maintenance and operation of the diversion. Both subwatersheds are in critical condition, and treatment is needed to reduce flood and sediment hazard. Under present conditions, the annual high flows of the San Juan River are adequate to move sediment deposits down the channel. However, with the authorized construction of Navajo Dam, the flow of the river will be stored. Irrigation water releases from Navajo Dam will be insufficient to flush out the accumulated sediment. Aggradation of the San Juan River below Navajo Dam is expected. This aggradation will affect the Hammond project diversion because of deposition of sediment from Pump and Gobernador Canyons. Other subwatersheds will also deposit their sediment in the river channel along the project lands.

The larger subwatersheds have defined channels across the project lands which will contain most of their floodflows. In project plans the Bureau of Reclamation has given consideration to stabilizing these drainageways and crossing them with canal structures. Project plans also contemplate concentration of small drainages into a few well stabilized channels across project lands. These subwatersheds are not considered critical to the operation of the project.

Land Treatment

It is recognized that treatment of watershed lands tributary to the Hammond project is important to the control of erosion and sediment. A primary objective should be to improve vegetation and soil condition. Adjustment of livestock numbers and improved methods of range usage are essential for control of erosion and sediment production. In addition, such practices as reseeding, gully stabilization, fencing, and other erosion control measures will be needed on certain critical areas. Estimates of needed treatment of Pump and Gobernador subwatersheds and minor un-named drainages above the diversion are shown in table 16.

Table 16.- Recommended land treatment for Pump and Gobernador subwatersheds, Hammond project

Kind of treatment	Unit	Estimated amount				
		Private land	Federal land		State and nonfederal land	Total
			BLM	Indian		
Sage and Juniper eradication	Acre	5,289	40,000	4,428	2,583	52,300
Reseeding	Acre	7,934	10,000	6,642	3,875	28,451
Erosion control structures and stock water development	Acre	18,490	105,832	15,480	9,030	138,832
Fences	Mile	86	100	72	42	300
Pitting, contouring, and water spreading	Acre	13,210	20,000	11,059	6,451	50,720
Grazing control and management	Acre	26,560	116,480	22,080	12,800	177,920

In addition to the treatments recommended in table 16, watershed lands located in tributary drainages, other than Pump and Gobernador, and administered by the Forest Service, Bureau of Land Management, Indian Service, State of New Mexico, and private individuals may require watershed treatment for control of erosion. Treatment of these lands is not considered basic to the Hammond project; however, intensification of the regular programs now being applied, such as grazing adjustment, livestock water development, fencing, reseeding, etc., will reduce operation and maintenance costs as well as extend the life of the project.

Private landowners have available the assistance of the San Juan Soil Conservation District and the New Mexico Cooperative Extension Service to develop and apply grass management and other conservation practices. At the present time, twelve ranchers in the watershed are cooperating with the San Juan Soil Conservation District.

Irrigation Aspects

Structural measures and channelization have been planned where major drainages intersect the canal system and cross project lands. Small areas of local runoff, due to heavy rainfall above the canal system, can be handled by regular ditch operation and maintenance.

Silt retention structures on the watershed above the canal intake and other watershed treatments are needed to reduce the amount of silt and sediment carried into the system. These structures or treatments are not necessary for the successful operation of the system but would lengthen the life of the structures and reduce maintenance costs. Runoff will have very little effect on farm irrigation ditches.

Findings

Generally, watershed lands have poor vegetative cover. They produce flash floods which contribute large amounts of sediment to the San Juan River. The larger drainages, which pass through project lands, already have well established channels to carry floodflows. Project plans call for the collection of runoff from numerous small drainages so that they may be passed through the project in protected channels. Lowlands in danger of flooding or seepage from the San Juan River will not be developed for cultivation. No additional watershed treatment is required for success of the project.

Consideration should be given to treatment of the watershed area of Pump and Gobernador Canyons because these drainages enter the San Juan River above the Hammond project diversion. Other upstream drainages will not have an adverse effect on the project after construction of Navajo Dam. However, means should be provided land-administering agencies and assistance made available to private operators of watershed lands to improve watershed conditions. Such action will benefit the project by lessening the threat of flood and sediment damage, thus reducing operation and maintenance costs and prolonging the useful life of the project. Needed improvements should be carried out through regular and special programs as rapidly as possible.

CHAPTER V

REGULAR ACTIVITIES OF THE U. S. DEPARTMENT OF AGRICULTURE PARTICULARLY AFFECTED BY THE HAMMOND PROJECT

Introduction

The U. S. Department of Agriculture and the New Mexico College of Agriculture and Mechanic Arts are carrying out a number of agricultural activities in San Juan County, New Mexico. This is being done under regularly established programs. With the increased agricultural activity brought about by the project, these regular programs will need to be accelerated. Assistance supplied by these programs will materially aid and accelerate the development of project lands.

Agricultural Education and Information

The New Mexico Agricultural Extension Service maintains an office at Aztec. The services of a resident county extension agent, an associate county extension agent, and a home demonstration agent are available to farmers in the project area. The services of the nonresident extension specialists located on the campus at State College are also available to the limit of travel resources and time in serving the entire state. As the project is developed and expanded, additional information and educational services will be required to adequately serve the farmers of the area. Information as to improved practices of fruit, forage, and livestock production, as well as better irrigation water management and pasture development, will need to be emphasized.

Technical Services

The Hammond project lies within the San Juan Soil Conservation District. The Soil Conservation Service has two work units in the district staffed with an engineering specialist and engineering aid in addition to two work unit conservationists. Specialist assistance in the fields of soils, engineering, agronomy, and range management is provided by technicians headquartered at Albuquerque.

Farmers occupying irrigated lands in the district and operators utilizing watershed rangelands have been provided technical assistance by Service technicians in planning and applying conservation practices.

Additional technical services and on-site assistance from Service technicians will be required in the planning and application of conservation measures, such as land leveling, farm irrigation systems, water management, soil-building practices, cropping practices, and grass management.

Farm Financing

With the completion of this project, complete farm development, including housing, farm buildings, and land preparation, will be necessary on most farm units. It is anticipated that some farm enlargement will be necessary where owners now have units of insufficient size. Development of domestic water supplies will also be required. A majority of the operators will require financial assistance for the purchase of livestock and equipment and for annual operating expenses. It appears that the Farmers Home Administration credit programs will be called upon to provide assistance for the work outlined above, resulting in a need to increase those credit programs.

Cost-Sharing for Conservation Measures

The San Juan County ASC Committee has been cooperating with the farmers throughout San Juan County to obtain more effective and beneficial use of available irrigation water. Pooling agreements have been used to offer cost-shares to groups of farmers to solve their conservation problems. The San Juan County ASC Committee with present facilities should be able to cope with any accelerated pace of activity caused by work on the Hammond project. The completion of the Hammond project will require additional reorganization of farm irrigation systems on the affected lands.

National Forest Land

Because of the distant location of national forest lands from project installation, the regular program of the Forest Service will have relatively little effect upon project operation and maintenance. The going program on national forest land includes measures for the restoration and proper management of plant cover and the maintenance of soil stability. These activities will aid the general watershed protection objective of reducing floodwater and sediment hazards to project installations and their maintenance.

Research Needs

A comprehensive report covering general research needs for the area of the Colorado River Storage Project will be developed by representatives of the U. S. Department of Agriculture research agencies, state agricultural colleges, and experiment stations. As far as the Hammond project is concerned, there appear to be no research needs peculiar to this project that would not be covered in the above-mentioned report.

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